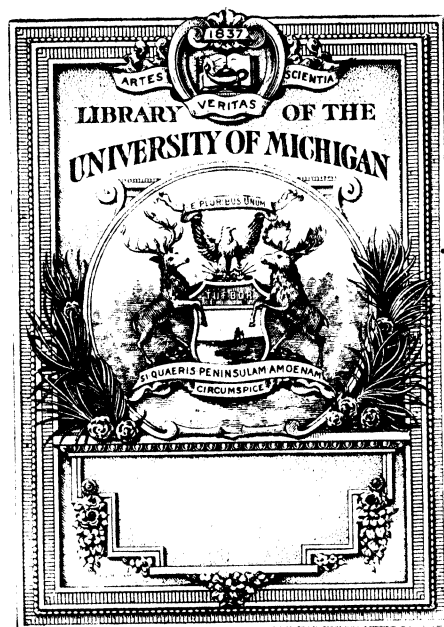
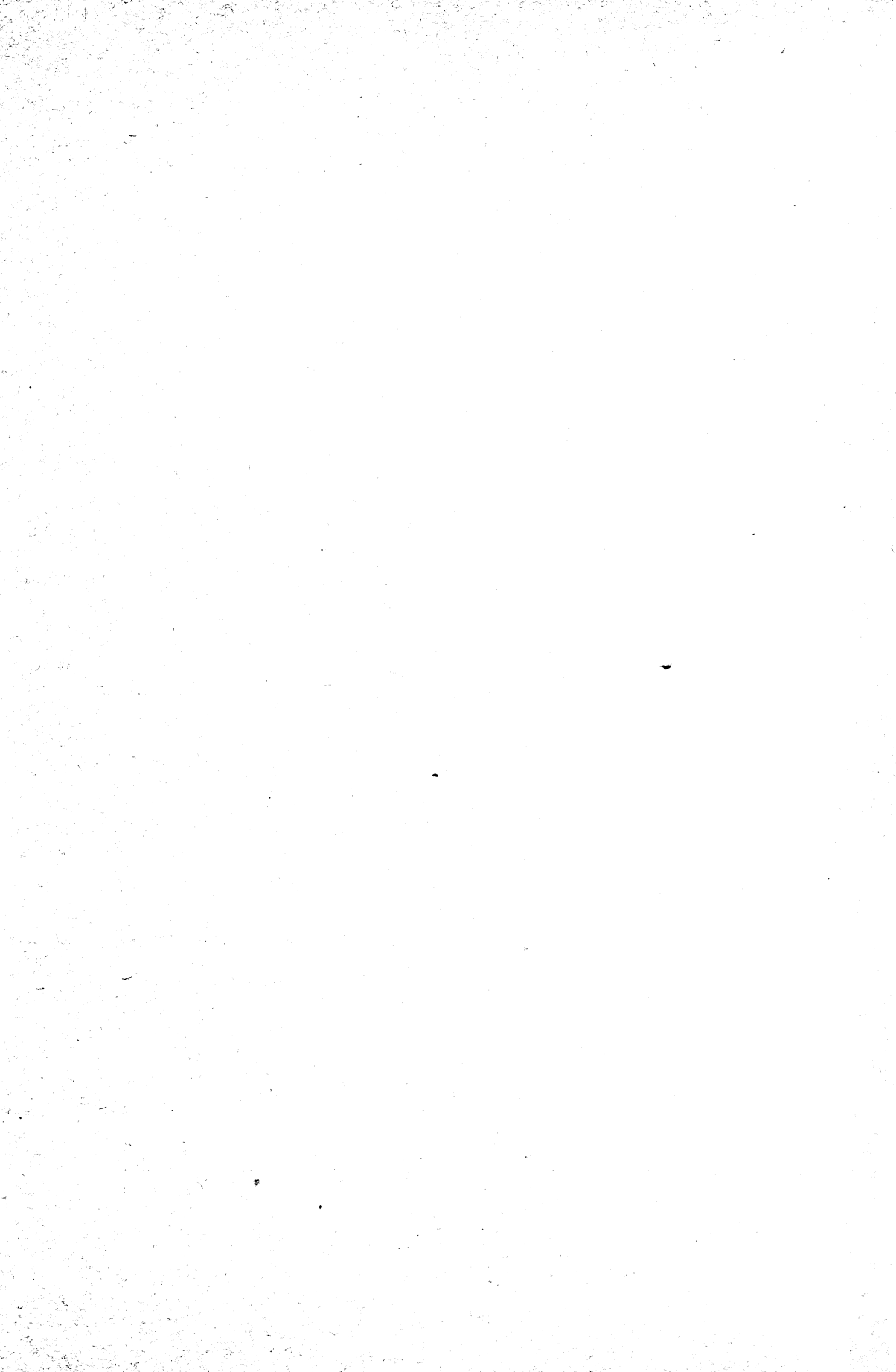


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FIFTH ANNUAL REPORT
OF THE DIRECTOR OF
THE BUREAU OF SCIENCE

TO THE HONORABLE
THE SECRETARY OF THE INTERIOR

BY
PAUL C. FREER
DIRECTOR OF THE BUREAU OF SCIENCE

FOR THE YEAR ENDING AUGUST 1, 1906



MANILA
BUREAU OF PRINTING
1906

FIFTH ANNUAL REPORT OF THE DIRECTOR OF THE BUREAU OF SCIENCE.

DEPARTMENT OF THE INTERIOR,
BUREAU OF SCIENCE,

Manila, August 10, 1906.

SIR: On November 1, 1905, the Bureau of Government Laboratories was increased in its scope by the addition of the former Bureau of Mines, which was merged with it as a division. At the same time the title of the Bureau was changed from the one which it held since its foundation, the new designation being "The Bureau of Science." In foreign countries some misunderstanding has been caused by this alteration in title, and, as a result, inquiries have reached us asking whether two scientific organizations had been established in the Philippine Islands; however, such misunderstandings have been few, and now the institution is known as the Bureau of Science throughout the world.

The fusion of the work in mining, mineralogy, and geology with that carried on in the Bureau of Government Laboratories has of necessity caused some rearrangement of the space in the building and a considerable amount of crowding. It will be recalled that the original plans provided that the main building should be used for laboratory purposes only and that separate wings, to be adapted for the use of the other Bureaus of the Government which have a more or less intimate connection with scientific study, were designed and in these wings space was to be provided not only for the work in conjunction with the mineral resources of this country but room was also proposed to be set apart for the growing collections appertaining to the studies in botany and zoölogy. A fundamental prerequisite for any successful extension of our geological and petrographic studies is an adequate and systematic collection, and even the daily work of the division of mines is such that many specimens which ultimately are not permanently retained must be handled. The same may be said of botany and zoölogy.

The Bureau, so far as was in its power, has provided for the placing of the working collections used by the branches of science which have just been referred to, and, to accomplish this end, space in this building was used for purposes other than the ones for which it was originally intended. Fully equipped laboratory rooms have been devoted to collections and to topographic work, and as a result the staff in the experimental scientific branches has become unduly crowded. We have

been compelled to assign the room which was originally devoted to physiological chemistry to the chief of the division of mines; another, which was occupied by the serum division, to the geologists of the Bureau; a third, which was used by one of our chemists, to the topographic work; three of the rooms originally intended for medico-biological investigation have been devoted to botany and entomology, and the space set apart for pharmacology has been given to the collector of natural-history specimens. The rooms thus set aside are not adapted to their new purpose; they were planned for laboratory work, and in this field they find their most economical use.

The systematic work of the Bureau, giving as it does an insight into the distribution and nature of the fauna and flora and of the geologic and petrographic resources of the Islands, is of fundamental importance and must be continued. The collections, which are necessary, must continue to grow. They are too far advanced and too valuable not to be maintained and not to have begun them would have been a misfortune, as the time which has been gained for these important branches of scientific work would have been lost. It is too often the complaint of scientific institutions which in their early career have neglected the gathering of adequate collections, that subsequent efficient work has been sadly hampered if not stopped by the lack of reference material. It is only a question of time when some means will need to be taken to enlarge the space occupied by the Bureau of Science. The collections which we have, should be well arranged and placed in such a condition that, just as is the library, they would be available to all without having the advent of visitors materially interfere with the daily work being carried on. Therefore, it would not only be desirable but soon it will be necessary to have a wing connected with this building constructed according to the original plans, not only to house in it the working collections of the Bureau but to extend its scope so as to provide space for other scientific materials to be studied and utilized by our investigators and the public. A lecture room capable of accommodating between 200 and 300 people should be an adjunct to this wing and should be well equipped for general purposes of scientific instruction. The construction of a museum building in some other portion of the city will not answer the purpose, as the working collections must be directly accessible to the persons in the Bureau using them, and the moving of the members of the staff whose work depends on these collections to some other point would destroy the free intercommunication between the various members of the Bureau, which has proven itself advantageous to all branches of work. Frequent consultations between the units of the staff are of vital importance to the Bureau and are one of the most important results gained by the system of scientific centralization which we have adopted. Were this institution in the United States, there would be small doubt but that

private funds could be obtained for the new wing, but situated as we are, such a desirable end would appear to be doubtful.

On January 1, 1906, the original form of the publications of this Bureau was abandoned and the issue of the *Philippine Journal of Science* undertaken. The *Journal* is as yet in its first volume and seven numbers have been published. The material has been ample and the recognition which it has received is such as warrants us in predicting its permanency. It is a frequent custom among scientific men and university libraries not to subscribe to a journal until it has completed its first year and shows promise of continuing. Therefore, it is gratifying to note that in spite of the fact that professional men in Europe and America have as yet seen only the first three numbers, the subscription list covers practically all parts of the globe. The exchanges have also been very encouraging, their value at present being nearly ₱2,000 per year, although the negotiations with many other publishers are not, as yet, completed. These exchanges represent a real saving as, were we not to have them, the subscriptions for these journals would need to be paid from the appropriation for the library.

Difficulties have been encountered in more ways than one. The procuring of entirely satisfactory lithographs of maps and of drawings in Manila has been difficult, but it is hoped that in the future, excepting where there is urgency in publishing an article, time enough will be available to procure our lithographs from firms of acknowledged pre-eminence in this line of work.

One handicap under which the *Journal* labors is the varied nature of the articles which fill its pages. Even during the first year it seemed advisable to separate the articles on systematic botany, of which a considerable number would with certainty be presented for publication, as a series of separately paged supplements, but as the papers read at the Philippine Islands Medical Association are now available in addition to those prepared by the Bureau staff, it has become evident that in issuing the next volume, a separation can be made into at least three sections, in conformity with the plan of issue of the *Philosophical Transactions* or of the publications of the Vienna Academy of Sciences.

The subscription price of the *Journal* at present is \$5 a year. It would be feasible to separate the *Philippine Journal of Science* into three sections beginning with the next volume. One of these sections should be devoted to the biological work immediately connected with tropical diseases, the second to general scientific papers, and the third to systematic botany and botanical subjects. The subscription price should then be \$3 a year for the medical section and \$2 each for the others; the whole *Journal* to cost \$5 a year as heretofore. This lower total price would be a sufficient inducement to warrant subscriptions to the entire series and yet those specialists who are interested only in certain lines

would be able to procure as a complete volume that portion of the Journal which they desire. The cost of publishing in this form would be but slightly greater than it is now, as it would amount to no more than the payment for the additional covers, title pages, and indexes. Undoubtedly the income to be derived from subscriptions would be increased.

A great amount of work is necessary conscientiously to edit and thoroughly to advertise a journal of this kind. As a rule, editors are divorced from the business management of their journals, but under the present circumstances it has been impossible to do this in the case of the Journal of Science. It is hoped that, during the next year, the list of subscribers will increase to an extent to warrant the employment of some one to attend to the business management of the Journal. It has been the constant hope of the Director of this Bureau once more to be able to devote a certain amount of his time to experimental work. It is true that very many researches are carried on in the institution in all of which the Director is interested and in many of which he helps by his advice and suggestion, yet he has never, with any certainty of continuing, himself been able actively to participate in laboratory work. For this year the publication of the Journal of Science has rendered the hope futile.

The series of bulletins of the Bureau of Government Laboratories was completed by the issue of No. 36 in January, 1906. There is now a great call for these publications and several numbers of the series are out of print.

The personnel of the Bureau has suffered many changes during the year. Drs. Herzog and Lewis, and Messrs. Bliss, Hare, and Williams returned to the United States. Dr. Woolley left for Siam, there to assume direction of the Government laboratories about to be inaugurated. Dr. Sorrell, the veterinarian, was transferred to the Agricultural Bureau, Dr. Whitford to the Bureau of Forestry, and Dr. Copeland to the Bureau of Education, and as a result we have been compelled to call upon the Civil Service Board for many renewals in the force. At present we are looking forward to two further changes in the chemical division. This condition is unfortunate from the standpoint of economy, for everyone who newly enters the Bureau must of necessity be ignorant of the field of work in the Philippine Islands and must be with us at least a year before his full value is developed. While it has been found possible to secure efficient men of reputation in the higher-salaried positions, the same can not be said of the ones which carry a yearly stipend of between \$1,400 and \$1,600. During the entire year we have been unable to secure a satisfactory botanist at \$1,400, and as yet have no certainty as to the three chemists at \$1,500 to \$1,600, respectively, whom we are seeking in the United States. This would seem to be an argument in favor of

the belief that the lower places are not paid adequately enough to secure the proper men, yet I am rather inclined to the opinion that the chief reason is to be found in a disinclination of scientific workers to leave their own country where the field for investigation is certainly adequate, to come so far abroad, even though we pay much higher salaries than they have been receiving in their home institutions. It is also possible that the conditions of the service in general are not sufficiently understood, and that some who have returned during the earlier year of organization have given more or less unsatisfactory reports. However that may be, the opportunity certainly is a good one for energetic and well-trained scientific men, and if good and capable young men can be obtained for the lower posts, nothing will stand in the way of their promotion to the higher ones. By means of the present arrangement of the salary list, the distinctions between the various divisions of the Bureau can gradually be abolished, so that a properly equipped man entering at one of the lowest positions, can have before him the opportunity for promotion upward through all the authorized salaries of the institution. This flexibility in the appropriation will very much increase the rapidity with which a new employee would advance, as he no longer will be compelled to wait for vacancies in his own particular division but would have an opportunity for advancing whenever a vacancy took place in any division, provided always he showed himself to be capable and fit for promotion. It is a fact that men who entered the Bureau three years ago at a salary of \$1,600 a year are now receiving \$2,000, and, by reason of future changes, will soon be enjoying a still larger income.

It is to be hoped that, owing to the recognition which the Bureau has obtained from scientific institutions and societies throughout the world and the growing feeling in America that in the Philippines we now have a thorough organization of high standing with ample facilities and an efficient means of bringing its work before the world, well-equipped young men will be willing to enter the Bureau in the lower positions with the hope and expectations of working their way to the top. The difficulties which have existed in the past will become less as time goes on.

Every member of the laboratory force must have spent much time and money in his preliminary education. He must be a graduate of a university and in addition must have done graduate and research work. Many positions in the United States are open to such graduates, and therefore their condition in the Philippine Islands should be so improved and they should have such congenial surroundings that they would not feel any loss owing to their having joined this Bureau.

Conditions have improved in the past few years and we look for still greater advances in the future, but obviously, men who have been compelled to acquire their preliminary training at so much expense feel that they are entitled to more consideration and probably to more salary than

are incumbents of other positions who bring with them nothing but an ordinary education and equipment.

Contact between the various members of the Bureau has this year been promoted by the organization of two journal clubs, one in the biological, the other in the chemical division. In these journal clubs the current literature is reviewed and discussed. This procedure has done much to promote a feeling of scientific unity among the members of the staff and it is hoped that it can be extended in the future so as to include the other branches of work as well. Scientific isolation is the greatest handicap we have to contend with in the Tropics, and this condition can only be ameliorated by the freest and most general contact among the members of the force.

THE LIBRARY.

The library has shown a steady growth. Many of the sets which were ordered at the time the Bureau was organized could not be obtained in a complete condition and frequently many shipments were delayed for from three to four years. This necessitated our constantly retaining balances from past fiscal years and ultimately the task of keeping them in order became burdensome. Some of these balances lapsed and reverted to the Treasury. As a result it was finally agreed to cancel all back orders for books and to renew them in the present fiscal year, the money to meet these new obligations being provided by economy in the entire Bureau during the course of the fiscal year 1906. The result has been very successful as, by reason of renewing these orders with other dealers, we now have on the way a considerable number of complete sets which we were not able to obtain through the old orders.

The cataloguing of the library and the preparation of a shelf list has progressed as rapidly as circumstances would permit. Owing to the lack of quarters, library shelves, and clerical assistance in the first years of the organization of the Bureau, and at the very time when books were being rapidly received, the cataloguing, accessioning, and the preparation of a shelf list fell far behind. The librarian's time was taken by the details attendant on the purchase of books and the checking, preparing for binding, placing on the shelves, and tracing of the various parts of volumes through the rather complex payment vouchers. This task was rendered much more difficult by the fact that in many of these vouchers attempts had been made to translate foreign titles into English, and, in any event, they had been prepared by persons not familiar with books or with foreign languages. As a result, the deciphering of the details which are necessary properly to classify a library has been most difficult, and therefore a card list, representing each book purchased, together with the necessary data, has only just been completed. The difficulties have also been increased by the fact that we have received as free gifts from the United States and from foreign governments, from academies and socie-

ties, many series and pamphlets, all of which must be taken care of and shelved in the same way as books purchased. In a library which not only has a large subscription and exchange list but which also receives many unbound books, the preparing of volumes for the bindery is no small task. The work must be carefully done, the sets must be complete with indexes and illustrations, and on their return they must be checked to see that no part of them has been wrongly bound or mislaid.

The responsibility and duties connected with this work falls on the librarian, who in addition must constantly be prepared to assist in finding books of reference, to loan books and to call them back when taken out on cards, and in other ways to facilitate the circulation of scientific literature.

The fundamental principle in the establishing of a library of this kind is at the beginning to obtain books as rapidly as possible, to place them on the shelves with the least possible delay and to have them available for use, for only by this means can the library become an adequate adjunct of the scientific work, but such rapid accumulation of material necessarily brings with it the impossibility of attending to all the details which are necessary thoroughly to accession and catalogue. When the librarian has to be business manager and cataloguer, when she must attend to the circulation of the books, to the binding, and in addition to the mailing of the publications of the Bureau, it is manifest that her time is more than fully occupied. At home, library institutions of the size of our own certainly have four or five assistants in addition to the librarian. We have been able to do much with the librarian alone and with two Filipino helpers at salaries, respectively, of \$20 and \$25, United States currency, per month, but we can not do all, nor can we catalogue and classify as rapidly as we could wish with this force. In the past few months much assistance to the librarian has been given by using the spare time of the stenographers of the Bureau, and for two months we temporarily engaged a library cataloguer to start the work of classification, but such fragmentary and desultory work is not as effective as continued endeavor. It is to be hoped that in time we will be able to secure one or two well-educated Filipinos who will be willing to enter the institution with the intention of fitting themselves for library work and who will be willing to remain with us. Such helpers at first would need to be contented with very small salaries, for they would be of but little value, but it is only by this means—namely, of beginning with educated Filipinos at small salaries—that we ultimately can hope to secure a properly trained corps of library assistants.

During the past year the library, through the honorable the Secretary of the Interior, received ₱2,906.80 as its portion of the payment by Mr. E. E. Ayer, of Chicago, for a set of the photographs of the Philippine Government. The catalogue accompanying this set was prepared by

Mr. Worcester and the sum thus made available represents the difference between the authorized sale price of the prints and the amount paid by Mr. Ayer for the prints and catalogue. The thanks of the Bureau are due both to Mr. Ayer and Mr. Worcester for their efforts in behalf of the library.

THE DIVISION OF BIOLOGY.

The Biological Laboratory during the past year has been very much hampered in its work by the sickness and absence of a number of the members of its staff. Dr. Musgrave was on leave in the United States during the latter part of 1905; Dr. Herzog left in April, 1906, and Dr. Marshall, his successor did not reach Manila until toward the end of July; Mr. Hare returned to the United States on the 1st of January, 1906, and Dr. Ohno, who took his place, did not reach Manila until the 21st of June. Nevertheless, many important results were obtained. Despite the routine work which at times, owing to the recrudescence of cholera, was very severe, the development by Dr. Strong of our cholera vaccine which consists of the extracted and filtered immunizing substances from the spirilla, continued and its manufacture was undertaken by Dr. Ruediger, of the Serum Laboratory. The process by which this vaccine is prepared is one which requires the most intense attention to detail and any variation from the prescribed method or contaminations by other organisms are fatal to its success. However, a great advantage of this method is that the vaccine can be thoroughly tested and hermetically sealed after testing, so that absolute certainty as to its freedom from contamination can exist before it is used. The same can not be said of methods which use living organisms. In spite of the difficulty attendant on its preparation the Bureau was able to prepare for use a sufficient amount of vaccine to enable it not only to vaccinate all who volunteered for this purpose at the laboratory but also to undertake work in the field, the latter being chiefly carried on by Dr. Edwards and Mr. Clegg.

The first provincial point at which any extensive cholera vaccinations were practiced was Angat and its barrios, in the Province of Bulacan, where 1,078 individuals (about one-sixth of the inhabitants) were vaccinated. Since that time 122 cases of cholera have appeared in Angat, 121 of which were among the uninoculated and only one among the inoculated.¹

The next places visited were Siniloan and Mabitac, in Laguna Province, where 1,879 and 527 persons, respectively, were also vaccinated. These villages do not offer the same opportunity to draw conclusions as to the results, because cholera has not to any great extent appeared in their neighborhood since they were visited by our men, but nevertheless it should be stated that there was but one case of cholera in Siniloan since the vaccinations. In Manila, on Calle Antonio Rivera, 116 received

¹ These statistics are up to November, 1906.

cholera vaccine and, although some cholera has occurred in this street since that time, none has appeared among those vaccinated. At Malolos 300 individuals were vaccinated, but as yet the work there is too recent to be reviewed.

In Bilibid Prison one-half of the prisoners were given cholera vaccine early in September, 1905, and afterwards no cases of cholera appeared in the institution until quite recently, the disappearance of cholera in the prison being simultaneous with the vaccinations but due to other sanitary measures. In the month of June, 1906, one of the vaccinated inmates became infected and died. As the interval between the time of vaccination and the date when cholera reappeared in Bilibid was about ten months, it seems certain that the immunity originally conferred must have disappeared.

Vaccination in which the specific vaccine confers a blood immunity against typhoid has been practiced in the German army, especially among the forces which have been sent to Africa, and it is an incontestable fact that the frequency of the occurrence of the disease among these troops was much lessened by the use of vaccine. In addition, it is established that the infection in the vaccinated takes a much milder course than it does in those who have not been so treated. As the cholera vaccine also confers a blood immunity which is even a higher one than is to be obtained by the use of typhoid vaccine, the conclusion is obvious that vaccination against cholera should protect even in a greater degree than does that against typhoid. It is the opinion of all who have been actively concerned with this work in the Bureau that the method best adapted to limit or to eradicate endemic cholera in any country is by vaccination, just as smallpox has been limited by similar means. That vaccination will entirely remove cholera from a given country is not to be supposed, any more than that smallpox vaccination has accomplished the same end with the disease against which it is practiced, but vaccination against cholera would certainly remove the danger of extended epidemics just as has been the case with smallpox and consequently it would remove the necessity for a burdensome and costly quarantine and for many other disagreeable sanitary measures.

In order to prepare large quantities of cholera vaccine, machinery adequate to the purpose must be purchased; among other pieces of apparatus, a somewhat expensive centrifugal, capable of taking from 10 to 12 liters at a time, is necessary. Therefore, the Bureau has not felt justified in buying and mounting a centrifugal in advance of any fixed policy to begin general vaccination which might be adopted by the health authorities. If such a course should be decided upon, the apparatus could be ordered promptly and large quantities of vaccine could be furnished within four or five months after the date when the decision would be reached.

Although plague has not by any means been as prevalent as cholera, nevertheless, the biological laboratory has continued to develop a plague vaccine by a method depending upon the use of attenuated organisms. The protection to animals afforded by this vaccine is not perhaps as uniform as in the case of the prophylactic against cholera, but nevertheless in the blood immunity conferred it is superior to any of the previous methods adopted. While working in this direction Dr. Strong has also investigated the immunizing powers of the aggressins, but has come to the conclusion that as a prophylactic against plague, our vaccine is much better.

Dr. Musgrave has continued his work on amœbic dysentery besides taking the daily service at Bilibid Prison. The results have been most interesting in several particulars, the conclusion having been reached that amœbæ which have been isolated from the stools of dysenteric patients and which, together with their symbiotic organisms, were apparently virulent eighteen months ago and capable of causing liver abscess constantly, have, after being transplanted in culture during many months, become avirulent and powerless to produce this pathologic result. Furthermore, Dr. Musgrave has reached the conclusion that the various types of amœbic liver abscess are only brought about through amœbic infection when a condition of previous toxic weakening of the organ has occurred.

The autopsies at Bilibid Prison have been a most prolific source for the discovery of infections by animal parasites. Dr. Musgrave up to the present time has encountered five cases of paragonomiasis, two of which were general infections. The fact that during the last few months so many instances, both fatal and otherwise, of this class of infection have been encountered has made apparent the necessity of a member of the laboratory staff who is a medical zoölogist, and therefore fully conversant with the methods employed in determining and cultivating organisms of this class. Steps have already been taken to secure a properly equipped man for this work.

Dr. Herzog, before his departure for the United States, was given an opportunity to proceed to Japan to study the large amount of beriberi material which had been collected in that country by reason of the return from the front of many soldiers suffering from the disease. When he again reached Manila he continued his studies with the material which was available here and demonstrated that the specific organism of the disease has not as yet been isolated, as was supposed to be the case by Okata and Kokubo in Japan. The results of his work on beriberi have been published in two extensive papers.

The routine of the biological division has been very heavy and therefore the other members of the staff have had but limited opportunity for extended investigations. During the cholera vaccinations in the provinces, which were mainly handled by Dr. Edwards and Mr. Clegg, the research work of the other members was necessarily restricted.

The Army Board for the Investigation of Tropical Diseases has recently been given space for work in the biological laboratory and the results of their investigations will be available for publication in the Philippine Journal of Science.

The work in the botanical section of the biological division has continued under the direction of Mr. Merrill according to the plan adopted in the past. The endeavor to build up the herbarium as rapidly as possible, the classification of materials, and the compiling of data of use in the economic problems of the Islands have continued without cessation, so that at present there are 28,823 mounted sheets in the herbarium, 7,978 specimens having been received during the year just completed.

Material has generally been identified upon receipt and in any event as rapidly as possible, and, owing to the fact that the library is now well equipped and the herbarium a representative one, the work has been more advantageously advanced than at any time during the past. Our relations with foreign botanists have been most cordial, and the classification of our material and our botanical publications have shown the results of coöperation with them. We have obtained identifications from many specialists and, in addition, their manuscripts in most instances have been submitted to us for publication. We have also entered into agreements with a number of institutions facilitating exchanges. As a consequence, it may safely be stated that we now have the most important and representative Philippine herbarium in the world and that the center for botanical work on the Philippine flora has been transferred to Manila. The herbarium is at present in such a condition that it can begin to serve as a basis for monographs on special groups of Philippine plants which are of value from an economic standpoint, and with this end in view a study of the rattans of the Philippine Islands has been begun and is now well advanced.

We are now in a position to take up histological work. As a consequence Dr. Foxworthy has begun a microscopical study of the leading Philippine commercial timbers, with the object of discovering characters which will facilitate ready identifications; but, apart from this, the development of the herbarium has of necessity left many economic problems for the future.

Another handicap to botanical work in the Bureau has been our inability promptly to secure a properly equipped man from the United States to take the place vacated by Dr. Whitford. The needs of botanical investigation are many. We should have a mycologist, an economic botanist, and a plant pathologist, but as we have but one position vacant, we are compelled to choose between the various branches we wish to study and to take whatever opportunity may be offered to obtain a botanist equipped in any one of the three fields mentioned. It is to be hoped that the vacancy will be filled in the near future, so that our

botanical development will begin to assume a broader scientific aspect than it has in the past. In spite of all obstacles, the progress has been most satisfactory and the possession of our herbarium is the best guaranty of continued successful work in the future.

The exchange of botanical duplicate material has continued and especial efforts have been made to secure specimens of the flora of the Indo-Malayan region in return for our output. The distribution of exchanges during the past year has been on the basis by which a specimen would be returned for one sent, and the results due to the adoption of this system are now apparent, for the herbarium of this Bureau will soon be representative of the flora of the entire region surrounding the Philippine Islands. After this end is attained, studies of relationships between the flora of these regions and that of the Philippine Islands can be more extensively carried on. As many of the countries have been more thoroughly explored than the one in which we are, the practical advantage of this phase of the herbarium is apparent.

The entomological section has not been as favorably situated for advance as the botanical one. It has suffered from the fact that the routine work of pinning and preserving specimens has devolved upon the trained employees of the Bureau, sufficient funds not being available to permit of training Filipinos solely to do this class of work. It is not an economic procedure to have the higher-paid scientific staff occupy its time in work which could be assigned to persons at a much smaller rate of pay and it is hoped that during the present year, by judicious management, the Bureau will be in a position to assist the entomologists in this work. The chief lines of investigation have been on the insects attacking the coconut palm (the results of which have been published), upon the locusts which attack the crops in the Islands, and upon the mosquitoes occurring in the Philippines. The work on the locusts was interrupted at the beginning of the dry season, owing to the death of all of our experimental material; that on the mosquitoes is progressing most favorably and as soon as possible will appear in the form of a series of papers.

Mr. Banks made an extended visit to the Provinces of Bulacan, Pampanga, Nueva Ecija, and Tarlac for the purpose of studying the best means of combating the locust plague and of instructing the inhabitants in the methods to be adopted for the destruction of the insects. This opportunity was used to transfer a large number of locusts to this Bureau. These were cared for in a cage built for the purpose. The result was that a great advance has been made in our knowledge of the life history of these insects, but the entire picture is not as yet completed.

The use of locust fungus has not been successful, and confirming this result we now have news from South Africa that, in that locality, this method of combating the plague of insects has also been abandoned. In the latter country the method recommended is the extermination of the

newly hatched young by fire and the driving of the larger individuals which attack the crops into trenches, these to be covered with earth or crushed. This has been the most efficacious method in the Philippine Islands and has been the one recommended in the provinces visited by the entomologist. In South Africa, sodium arsenite is being used against locusts, and there it is believed that this chemical will be the remedy of the future. This Bureau will endeavor to undertake some work in this field during the coming year.

The work on mosquitoes was begun by a visit to a temporary camp distant some 4 or 5 miles from Manila where a party was surveying the route for the new waterworks and in which a number of cases of pernicious malaria had occurred. Three species of *Anophelinae* were discovered. This work supplemented much that had been done in Manila, but as it seemed desirable to go to a place where all altitudes could be considered and where mosquitoes occurred in abundance, the entomologist visited Negros and studied the problem at various heights above the sea, at the same time investigating the occurrence of latent malaria among the inhabitants.

The question of limiting the mosquito pest of these Islands is still one to be considered in the future, but from a hygienic standpoint it will need to be undertaken before many years have passed.

The entomological section has also paid attention to the introduction of silkworm culture in the Philippine Islands, but the work is not sufficiently advanced for further mention. When completed, recommendations will be published.

Many requests of a routine nature looking to the destruction of pernicious insects have come to the Bureau and advice has been given to the best of our ability. The insect collection has grown satisfactorily during the year and many new species have been added to it. Mr. Willy Schultze has taken a large number of specimens to Europe, while on his leave of absence, it being his intention to spend some months at the British Museum, there to occupy himself with the work of identifying the material.

Mr. R. C. McGregor, who is in charge of the section of the biological laboratory which is devoted to the collection of natural-history specimens, returned from his leave in the United States on March 6, 1906, he having been absent during seven months, and soon after his arrival, together with the native collectors, he was sent to Bohol and Cebu, there to continue his work. Owing to this absence, the ornithological material collected was not as extensive as in the preceding year, although the native collectors were kept in the field as much as possible. The interesting results of the year's work in systematic ornithology have nearly all been published in the Philippine Journal of Science; the more extensive task of correlating our results and of publishing descriptions of Philippine birds, based upon the work which has been done, will begin during the coming year.

A Hand-List of Philippine Birds was prepared by Messrs. McGregor and Worcester and issued as the last number of our series of bulletins. In addition to its intrinsic scientific value, this hand-list will be useful in the Bureau of the purpose of checking duplicates which can be supplied for exchange and sale. Exchanges have been entered into for a number of duplicates in our ornithological collection and during the next year we hope still further to perfect the arrangements by which our representative collection can be increased.

A set of duplicate bird skins was sold to Mr. E. E. Ayer, of Chicago, the material being shipped on April 1.

THE DIVISION OF CHEMISTRY.

The chemical division during the past year has for the first time been able to enlarge its investigations more extensively in economic fields and as a result fundamental advances have been made.

The changes in personnel have not been so great as they were in the biological laboratory, Dr. Lewis and Mr. Bliss being the only ones who returned to the United States, their places being filled by Dr. Bacon, from the University of Chicago, and by Dr. Cox, from Leland Stanford Junior University, and this stability of the force is a sufficient reason for the large amount which has been accomplished.

Dr. Clover besides having direction of all the chemical work has continued the investigation on gums and resins, devoting himself especially to the terpenes and sesquiterpenes which may be obtained from them. A paper on Philippine wood oils has already been published, covering the oil of supa gathered from *Sindoro supa* Merr., oil of apitong from *Dipterocarpus grandiflorus* Blanco, and oil of panao from *Dipterocarpus vernicifluus* Blanco. From all of these oils sesquiterpenes of the very highest quality have been obtained.

Oil of supa can be gathered in these Islands in considerable quantities. The general value of sesquiterpenes as pure as the ones which we have obtained has not been established in the world's market, but samples have been sent to the United States and have received most favorable comment. Naturally, in order to introduce this class of oils to extended use a market must be created, as in the general trade they are but little known, but our investigations will give opportunities for those who are interested to establish a sale.

Another interesting feature of Dr. Clover's investigations has been the fact that in the various resins known in the market as Manila *elemi* to be obtained from the pili trees (*Canarium luzonicum* A. Gray), we have not only encountered different terpenes, but each individual tree, apparently of the same species and derived from a stand where the trees are close together, yields its specific terpene. The oil which has been

obtained from Manila *elemi* therefore is a mixture of several terpenes, as no care has in the past been taken to isolate the oil from distinct trees which have been identified botanically. By this means, Dr. Clover has been enabled to procure for himself, for study, considerable quantities of pure materials.

Work on Philippine fibers and fibrous substances for the purpose of investigating their suitability for paper making has been carried on throughout the year by Mr. Richmond. In order successfully to prosecute this work in a way which would give the data necessary for the paper manufacturer, some rather large apparatus typifying the machinery in use in the paper factories, was constructed in Manila. The results have shown that we have in our Philippine grasses, cogon (*Imperata exaltata* Brongn), and talahib (*Saccharum spontaneum* Linn); in the waste from the hemp stripping; the bamboos; buri palm (*Corypha umbraculifera* L.), the plantains, the husk from the coconut, and in several Philippine woods an extensive material for the successful manufacture of paper. Cogon and talahib, which at present occupy such large waste areas in the Philippines, can at comparatively small expense be manufactured into a very good quality of paper, and the waste from the abacá yields a pulp of the very highest grade.

The first portion of the work on paper has already been published. In it are given all of the data necessary for the paper manufacturer, because our facilities for this line of investigation now are sufficiently ample for us to approximate factory conditions and to make exact statements respecting the availability of our materials. The second portion of the work is nearly ready for publication and the data necessary to give manufacturers information in regard to the available supply of these raw materials, their cost, the expense of chemicals and machinery, etc., are rapidly being completed and will be available during the next year. It is hoped that this portion of the work will establish a new industry in the Philippines.

Mr. Richmond has also undertaken a systematic study of various oil-bearing seeds and fruits of the Philippine Islands, the oils being investigated for their utility in the manufacture of paints and for edible purposes, and a large portion of the data now gathered will be ready for publication in the near future. In this very interesting field several oils, hitherto of no commercial value, have been studied and a distinct commercial advantage to be derived from their use demonstrated.

Mr. Walker has completed and published his work on the oil produced from the coconut, which has continued for more than two years. The series of tables showing the relation between the oil contents of the nuts and their age and the quality and quantity of copra produced by trees in different situations have already proven of use to oil manufacturers. The study of the causes producing rancidity in coconut oil has also been

of great importance, and the demonstration that pure oil keeps for practically an indefinite period, as its rancidity is caused by mold in the copra and by impurities brought into the oil during the process of pressing, has been very useful in advancing our understanding of the conditions under which the oil must be preserved and copra dried and shipped. A study of the oil to be obtained from *pili* nuts has also been completed, but, owing to our present lack of commercial data covering the availability of the nuts and the amount which can be secured in the Philippine Islands, publication has been postponed.

We have finally been able to take up the study of the medicinal plants of the Islands, and Dr. Bacon who arrived less than a year ago has begun this important branch of work. The investigations will gradually be extended over as large a field as possible, the chemists working in close coöperation with the botanists. Much material has already been gathered, but a discussion of the results would be premature.

Dr. Cox has recently arrived to take charge of the work on weights and measures planned for this Bureau. As he has been especially interested in chemistry connected with minerals, he has undertaken the study of the gas produced by our Philippine coals and has shown that much can be expected from them as a basis for "producer gas." His results will be published during the following year.

The routine work of the division has been quite heavy; practically it has taken the time of three men—Messrs. Vivencio, Fox, and Salinger—and at times other members of the force engaged in research have been obliged to abandon their work of investigation to take up that of analysis.

THE DIVISION OF SERUMS AND PROPHYLACTICS.

Dr. Woolley, chief of the serum division, left the Bureau on April 1, and after that time Dr. E. H. Ruediger took charge as acting chief until July 1, 1906. On that date, after due consideration of all of the interests involved and because of the close relationship existing between serum work and the medical work in the Biological Laboratory, it was decided to abolish the serum division as a separate entity of the Bureau and to unite it with the biological division under the general direction of Dr. Strong, chief of the Biological Laboratory, with Dr. Ruediger as assistant and in immediate charge. The closer union of the biological and serum work can not fail to be advantageous to both.

At this time a change is contemplated in the system of caring for the rinderpest-serum cattle by which this portion of the work will be transferred to the Bureau of Agriculture after January 1, 1907. After this date the Bureau of Science will only be charged with the scientific side of the preparation and standardizing of rinderpest serum. This will render the direction of the Serum Laboratory more simple and will enable it to devote more of its time to the development of its proper sphere, and it will also be a financial saving for the Government, as the animals will be

cared for on a farm situated a few miles from Manila. The work in the serum division during the past year has consisted in the preparation of rinderpest serum, antiplague serum, plague and cholera vaccine, diphtheria and tetanus antitoxins, mallein, and vaccine virus for smallpox.

Up to the time of Dr. Woolley's departure, Dr. Ruediger especially took immediate charge of the preparation of all of the serum and prophylactics with the exception of rinderpest serum, the making of which was carried on at San Lazaro by Dr. Sorrell. Dr. Sorrell accepted a position in the Bureau of Agriculture, as a promotion, in February, 1906, and Dr. Shealy, veterinarian of the same Bureau, took his place. Dr. Shealy in turn was transferred back to duty in his original position in July and Mr. Newby is now in charge.

The plague serum has been much improved during the year, owing to immunizing the horses by means of virulent cultures. The difficulties of preparing cholera vaccine have already been dwelt upon, and here it may only be added that a constant and painstaking care is the only guaranty of success. During the year we have for the first time been able to immunize horses to a sufficient extent to have on hand a supply of tetanus antitoxin. This product has now been added to our list and is available for distribution.

Mr. Cheek, who has had charge of the preparation of vaccine virus, has undertaken a series of experiments to demonstrate the antiseptic value of glycerine in its preparation and to determine the value of benzol and toluol as sterilizing media for vaccine virus. His results have shown that after the addition of glycerine to vaccine virus there is a gradual decrease in the number of contaminating organisms, the virus being sterile after three months. It has been found that invariably the specific cause of vaccinia has been destroyed simultaneously with the contaminating organisms, so that bacteriologically clean vaccine is always inert. No difficulty has been found in keeping a sufficient amount of vaccine virus on hand to meet all demands.

The preparation of rinderpest serum has been modified during the year, as the method formerly employed of gathering the serum in cylinders has proven itself to be unreliable because of the great difficulty in preventing contamination by means of organisms, especially during the dry season. The result of this contamination has been that a large number of bottles of rinderpest serum which had been kept for some time were of necessity destroyed as useless in the latter part of this year. For this reason we have changed to a method by which the serum is collected in side-necked filter flasks by means of a vacuum. We are thus able to produce a more uniform product, with the minimum danger of contamination.

During the first part of the year it was thought possible to gain additional quantities of serum by centrifugalizing the blood clots, but subsequent experiments have shown that the serum so separated was

always profoundly contaminated with organisms and therefore valueless. As a result, this method, after a thorough trial, was abandoned.

During the first part of the period under consideration a great difficulty in obtaining virulent blood was experienced, but a canvass of the available cattle in the Islands developed the possibility of importing animals from Sibuyan, to be used as nonimmunes, and since this importation was begun we have had but little difficulty in keeping up the supply, although at times, owing to stress of weather, importations were long overdue. However, the animals are small and their cost is relatively high because only small lots are brought to Manila, so that it is always a source of regret that we are unable to find a cheaper and equally reliable source of virulent blood.

As a result of strenuous efforts the former dearth of rinderpest serum, which had come to be a serious matter, was relieved, and before the end of the year there was in the cold storage a large stock on hand. As a result we were enabled to cut down the rinderpest herd as rapidly as the animals acquired so high an immunity that the giving of virulent blood to them was no longer profitable. However, in the past six weeks there has been a very large demand for rinderpest serum, so that we are compelled once more to increase our herd to larger dimensions. This is rendered difficult by the fact that we can not now call for the cattle purchased by the Government from Shanghai, as these have all been sold, so that in the future we must rely upon the local market. Large animals suitable for serum purposes, are very difficult to obtain in Manila, and consequently the purchase of a proper herd of serum cattle will not only take time but the animals will not be as satisfactory as were the ones used in the past. Shipments of cattle from Shanghai to Manila have entirely ceased. Owing to this fact we have made attempts to utilize the large Australian cattle which are being imported into the Islands.

The risk in immunizing these cattle is much greater than it is with the Chinese ones. At first we experimented with immunizing twenty-eight Australian calves, and of these fifteen passed through the process without serious trouble; two died of rinderpest; four of a complication of rinderpest and foot-and-mouth disease and the others of various other diseases such as gastritis, Texas fever, etc. Six large Australian cattle were all successfully immunized in the latter part of 1905. At a later time we purchased six Australian cattle; three of these were lost through rinderpest; the remaining three, although they acquired the disease, were saved by the use of intravenous injections of antirinderpest serum. An attempt will be made to utilize these large animals for serum purposes, although the difficulties to be encountered are great because of their strength and wildness, which makes it a serious matter to handle them on the operating table. It seems reasonably certain that a large

percentage of the Australian animals can be immunized against rinderpest, although they are extremely susceptible, and if they can be handled we will use them to increase our serum herd. Their original cost is high, but at least two or three times as much serum can be obtained from each of them at a bleeding as from the Chinese animals, whereas the feed for the former is not much more expensive than it is for the latter. The use of these Australian animals will probably enable us once more to prepare serum in large quantities, but probably there will be an interval during which only a limited supply will be available.

During the first part of the year the possibility of obtaining animals for serum purposes from the Bureau of Supply diminished the cost of production of rinderpest serum. Now that all must be purchased, the expense will naturally be somewhat increased.

Dr. Woolley carried on some research work on rinderpest, the results of which have been published in the *Philippine Journal of Science*.

The occurrence of some cases of tuberculosis among imported cattle in these Islands will probably render it necessary for the laboratory to add tuberculin to its list of preparations.

THE DIVISION OF MINES.

The coal resources of the Philippine Islands promise to fill local needs in the future. So far as we now know, coal areas exist in Luzon, Batan, Polillo, Mindoro, Mashate, Negros, Cebu, Samar, Leyte, and Mindanao. The present price of Japanese or Australian coal is very high in Manila; we now are paying ₱11.58 per ton of 2,000 pounds for Japanese coal delivered at this Bureau. The lack of a cheap and good quality of coal is one of the greatest commercial obstacles we encounter in the Philippine Islands, and therefore it has been the endeavor of the division of mines to push the study of the coal deposits as rapidly as possible.

During the past year Mr. W. D. Smith, who already had carried on some geological and reconnoissance work upon selected coal fields in the Philippine Islands, was sent to Cebu. He traveled over that island and his preliminary survey demonstrated a probability of favorable returns from coal development. Following this reconnoissance he undertook a more complete investigation of the coal fields of the Carmen-Compostela region. Upon his return, after two months' absence, Messrs. Goodman and Ickis, field assistants, were sent to the same portion of Cebu to make a topographic survey and map of the region which it was proposed more extensively to study. This map is now practically completed, and when it is in suitable form Mr. Smith will return to the island, if necessary accompanied by Mr. Goodman, to complete the work. The results will be published as soon as they are available.

Petroleum has long been known to exist near Toledo in Cebu and in Tayabas but has not been developed, and since the insurrection but

little exploring work has been done. However, it is proposed to return to these places also and investigate the occurrence of mineral oil.

The analyses of the Compostela coal have been fairly satisfactory and the same may be said of its gas-producing power.

The question of the manufacture of producer gas and the utilization of the lower grades of coal has been brought into prominence in the United States since the experimental work carried on by the United States Geological Survey in 1904 at the Louisiana Purchase Exposition, because the results of this work seem to show that even the poorer grades of lignite may be made to yield values in excess of those of the best grades of coal, when the producer gas is used in gas engines.

The question of the development of the Philippine coal fields and of the most economic utilization of the grades of lignite and of bituminous coal is of fundamental commercial importance to these Islands, and it is certain that an adequate number of geologists to map the coal areas and to publish the data regarding the availability of the deposits within a reasonably short time would much more than repay the necessary outlay. The investigation of the Cebu coal fields, for example, has taken the time of the two topographers of the Bureau and of Mr. Smith for at least four months, and a return to the field to plot the geologic features on the topographic map will be necessary. During this time, work on other coal fields is at a standstill. The transfer of the Bureau of Mines to the Bureau of Science as a division will enable the chief of the division, on his return from the United States on leave, to take the field himself, and in this way we will be able to cover a large area more expeditiously, but even under these circumstances it would be advantageous to have more men in the field, so as to obtain extensive economic results which will be of commercial advantage in developing the material welfare of the Islands.

The policy of pushing work as rapidly as possible in certain individual fields is being carried on, but with the force on hand, even with concentration of effort, the area which can be covered in a year is but a small one. These arguments emphasize the statement given above that it would be a profitable undertaking for the Government sufficiently to enlarge the force in the division of mines to enable it to cover more territory in this important mineral branch in a less space of time.

While the division is very much interested in the coals, it can not neglect the other mining fields which promise to increase the prosperity of the Philippines. The work of Mr. Smith during the year has been in the coal fields, but he also must do all the paleontologic investigating for the division. The importance of this class of work can not be overestimated, as the knowledge of the fossil deposits of one region where coal beds occur, gives an indication of other probable occurrences in other parts of the Islands. A paleontologic study of one region and a

knowledge of the fossils there encountered serves as a guide to what may be expected in another situation if the same fossils are met with.

The attention of Mr. Eveland has necessarily been directed to field work in regions where mining operations for ore-bearing minerals are under way, and from November until April he was in Benguet preparing a report and map on this important region. The map is now complete and the work of compiling the geologic results well under way. The paleontology and stratigraphic geology of this region will be developed by Mr. Smith in conjunction with Mr. Eveland.

The mining field in Masbate has not been neglected. The chief of the division visited this region to make a preliminary survey of the mining conditions to be encountered and of the results obtained in the district of Aroroy. His observations have warranted the determination to send Mr. Eveland and Mr. Goodman to Masbate as soon as their present work is completed, to make a topographic survey and a geological reconnaissance of the region. There are many other problems which have been undertaken but which have advanced but slowly, owing to the lack of numbers in the division. These questions include the investigation of limestones for economic purposes; of clays, building-stone deposits, rocks suitable for cement making, and of other materials which would be of value for structural purposes in the Philippine Islands; the investigation of the placer mining industry and dredger ground in Pampanga, Nueva Ecija, and Rizal; the placer mining fields of Pigtao and Misamis, Mindanao; the mineral resources of the Agusan River region in Surigao and Placer, Mindanao; the exploratory reconnaissance of the mineral resources of the Cagayan River valley, and so forth.

The review prepared by Mr. McCaskey of the work done in Philippine mining and mineral resources during the past year would be too extensive for an annual report and therefore such information as we have available will be published in a separate pamphlet, to be issued by the Bureau. The individual results obtained by the geologists during their work in the field, together with the maps which have been prepared, will be issued in the *Philippine Journal of Science*. In the future the Bureau purposes to publish all of its maps in a canvas-backed, separate edition, in a form which will enable them conveniently to be handled. These will be placed on sale, together with a series of pamphlets covering matters of interest to the miners, but not of original, scientific value.

The asbestos deposits lying in Ilocos Norte along the flanks of the central mountain range and extending almost due north and south for a distance approximately of 30 miles, constitute a mineral deposit of sufficient importance to be mentioned, although no member of the Bureau has as yet had opportunity to visit it, so that the information is not original. This occurrence was known to the Spaniards before American occupation and mention has been made of it in previous reports. This

asbestos is probably in part of the chrysotile variety; it occurs in veins in serpentine and in less completely altered peridotites, the veins being from 2 to 10 inches wide. The fiber is in part silky and is from 1 to 8 inches long. Magnesite is also present in considerable quantities. This source of asbestos is sufficiently close to the sea to insure a fairly small outlay for transportation to points where coastwise steamers stop, and labor, timber, and water are reported to be reasonably cheap. The economic geology of Ilocos Norte constitutes another important feature for future work, which in time will need to be developed.

The chief of the division of mines has begun a series of studies on the volcanoes of the Islands and during the year has visited Taal and Canloan Volcanoes, the latter being partially in eruption at the time. As opportunity occurs we will continue to gather material in this branch of geologic investigation until it is ready for publication. An interesting description of the volcanoes might readily be prepared at the present time, but in respect to completeness this would be of little value. For example, the region covered by Taal Volcano probably extends from the seashore at Batangas to Laguna de Bay. This area is a very large one and therefore any understanding of the life history of the volcano would involve a study of great magnitude, as an examination of the present crater readily reveals the fact that it is only an incident in the history of the whole.

The important question of an adequate space for the mining division and the fundamental importance of a place systematically to group and to begin the collection of specimens typifying the mineral resources of the Islands and the geologic and paleontologic material which is accumulating has been pointed out. The initial cost of a wing to the building would not be very great, and from a business standpoint it is believed that the loss due to inadequate quarters and the inability properly to expand to meet future needs will far outweigh the interest and deterioration on a reasonable investment.

I am, very respectfully,

PAUL C. FREER,

Director of the Bureau of Science.

The SECRETARY OF THE INTERIOR, *Manila, P. I.*

APPENDIX.

Number of examinations made.

Nature of examination.	1905.					
	July.	August.	September.	October.	November.	December.
Feces	485	752	418	680	408	172
Urine	141	213	63	273	201	100
Blood	100	76	106	119	146	136
Sputum	402	505	373	586	486	289
Gonococci	1,252	1,351	1,649	1,318	1,339	1,283
Necropsy	40	72	118	41	60	30
Water	127	79	32	6	13	32
Analyses, miscella- neous	22	21	47	84	66	59
Bacteriological, mis- cellaneous	102	85	67	145	47	19
Assays	11	2	30	21	28	11
Total	2,682	3,156	2,903	3,273	2,794	2,131
Photos, 5 by 7	2,568	939	804	774	169	986
Photos, 8 by 10	102	8	2	4	50	101
Shop orders					2	27

Nature of examination.	1906.						Total.
	January.	Febru- ary.	March.	April.	May.	June.	
Feces	196	142	138	88	245	216	3,940
Urine	71	76	125	138	121	164	1,686
Blood	160	135	114	69	116	222	1,499
Sputum	394	178	363	352	207	250	4,385
Gonococci	1,524	1,201	1,157	1,393	1,137	1,101	15,705
Necropsy	47	35	26	19	32	75	395
Water	25	19	6	7	29	69	444
Analyses, miscellaneous	25	38	34	50	23	36	505
Bacteriological, miscella- neous	107	141	74	*10,266	*17,327	*13,190	*41,570
Assays	21	7	45	13	23	21	233
Total	2,570	1,972	2,082	12,395	19,260	15,344	70,562
Photos, 5 by 7	564	355	225	169	774	331	8,658
Photos, 8 by 10	2	24	45	22	2	22	384
Shop orders	8	23	15	18	3	20	116

*Sudden increase due to plague rats being examined during an epidemic.

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